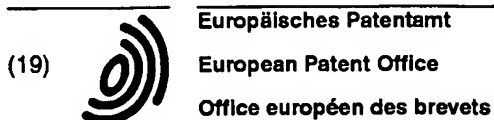


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(54) **CUTTING INSERT AND METHOD OF MAKING THE SAME****SCHNEIDEINSATZ UND DESSEN HERSTELLUNGSVERFAHREN****PLAQUETTE DE COUPE RAPPORTEE ET SON PROCEDE DE FABRICATION**

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- **DATABASE WPI Section Ch, Week 9113 Derwent Publications Ltd., London, GB; Class L02, AN 91-089543 XP002046638 & JP 03 032 502 A (KYOCERA CORP), 13 February 1991 & PATENT ABSTRACTS OF JAPAN vol. 15, no. 164 (M-1106), 24 April 1991 & JP 03 032502 A (KYOCERA CORP), 13 February 1991,**
- **DATABASE WPI Section Ch, Week 9637 Derwent Publications Ltd., London, GB; Class L02, AN 96-366613 XP002046639 & JP 08 174 310 A (MITSUBISHI MATERIALS CORP), 9 July 1996**
- **TSUDA K. ET AL.: "Development of Functionally Graded Sintered Hard Materials" ADVANCES IN HARD MATERIALS PRODUCTION, 27 - 29 May 1996, STOCKHOLM, SWEDEN, pages 45-52, XP002046636**

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## Description

### Background

[0001] The invention pertains to a coated cutting insert wherein the flank face has improved wear resistance and the rake face has improved impact resistance.

[0002] The article entitled "The Microstructure Features and Cutting Performance of the High Edge Strength Kennametal Grade KC850" by Nemeth et al., (Proc. Tenth Plansee Seminar, Metalwerke Plansee A. G., Reutte, Tyrol, Austria, (1981), pp. 613-627, mentions that, "... by combining a high impact resistant rake face with a deformation resistant flank face of a coated insert, we can substantially increase edge strength without significantly altering wear resistance." This article describes the use of a cutting insert which has a substrate with binder enrichment on the rake surface and the bulk microstructure (or composition) on the flank surface.

[0003] U. S. Patent No. 4,610,931, to Nemeth et al., (U. S. Reissue Patent No. 34,180) describes a coated cutting insert wherein the substrate has binder enrichment on the rake face and the bulk substrate composition on the flank face of the substrate. None of the above-mentioned documents presents a coated cutting insert with a substrate wherein the substrate has a flank face with improved wear resistance due to a flank surface region with a higher hard phase (e.g., solid solution carbide and/or carbonitride) content and a rake surface region with a microstructure (or composition) different from that of the flank surface region and which provides improved impact resistance.

[0004] WO 90/08613 discloses a cutting insert consisting of a cemented carbide body the surfaces of which are coated only partly with a coating of carbides, nitrides, carbonitrides and/or alumina. The coating is applied by a plasma-CVD technique to only the cutting edges with the rest of the surface of the cutting insert remaining uncoated.

### Summary

[0005] In one form thereof, the invention is a cutting insert that comprises a flank face and a rake face with a cutting edge at a junction thereof. The cutting insert has a substrate which comprises a bulk region that includes a metallic binder, and one or more of a first metal carbide, a first metal carbonitride, a second metal carbide, and a second metal carbonitride, either alone or in solid solution or in mixtures. The first metal and the second metal, which is different from the first metal, are each selected from the group consisting of the Group IVB (titanium, zirconium, and hafnium), Group VB (vanadium, niobium, and tantalum), and Group VIB (chromium, molybdenum, and tungsten) transition metals.

[0006] The substrate includes a flank surface region near the flank face of the substrate, and a rake surface region near the rake face of the substrate. The flank sur-

face region includes a hard constituent comprising one or more of a solid solution of metal carbides and carbonitrides of the first metal and the second metal. The content of the hard constituent in the flank surface region is greater than the content of the hard constituent in the bulk region. The content of the hard constituent in the rake surface region is less than the content of the hard constituent in the flank surface region.

### Brief Description of the Drawings

[0007] The following is a brief description of the drawings which form a part of this patent application:

- FIG. 1 is an isometric view of a specific embodiment of a cutting insert of the invention;
- FIG. 2 is a cross-sectional view of the cutting insert of FIG. 1 taken along section line 2-2;
- FIG. 3 is a cross-sectional view of a second specific embodiment of the cutting insert of the invention; and
- FIG. 4 is a cross-sectional view of a stack of cutting insert substrates.

### Detailed Description

[0008] Referring to the drawings, FIGS. 1 and 2 illustrate a first specific embodiment of a cutting insert of the invention, generally designated as 10. Cutting insert 10 is an indexable cutting insert which has a rake face 12, a flank face 14, and a cutting edge 16 which is at the juncture of the rake face 12 and the flank face 14. Cutting insert 10 further has a substrate 18 which preferably presents two rake faces 20 and 24, and a flank face 22 (which extends around the periphery of the cutting insert 10). Cutting insert 10 also has a coating 26 on the rake faces 20 and 24, and the flank face 22 of the substrate 18.

[0009] Referring to the substrate 18 of cutting insert 10, the substrate 18 has a bulk region 30 which is in the interior of the substrate 18. In the case of cutting insert 10, the bulk region 30 extends between the rake faces 20 and 24 of the substrate 18. The composition of the bulk region 30 is that of the basic bulk composition of the substrate 18.

[0010] The substrate further has a flank surface region 32 which extends inwardly from the flank surface 22 toward the interior of the substrate 18. As will become apparent from the discussion set forth below, the flank surface region 32 has a microstructure (and composition) that is different from that of the bulk region 30. Very briefly, the flank surface region 32 has a solid solution carbide content that is higher than the solid solution carbide content of the bulk region 30. FIG. 2 depicts the thickness of the flank surface region 32 in an exaggerated fashion for illustrative purposes. The typical thickness of this region is between about 10 micrometers ( $\mu\text{m}$ ) and 20  $\mu\text{m}$ .

[0011] In a preferred embodiment for a cemented carbide, the bulk composition of the substrate is a tungsten carbide based cemented carbide containing at least 70 weight percent tungsten carbide, and more preferably, at least 80 weight percent tungsten carbide. The binder is preferably cobalt or a cobalt alloy and, preferably, has a bulk concentration of between about 2 and about 12 weight percent. The more preferable bulk cobalt content is between about 5 and about 8 weight percent. Even more preferably, the bulk cobalt content is between about 5.5 and about 7 weight percent.

[0012] The bulk composition of the substrate also preferably contains (although it is not a necessity) solid solution carbide forming elements such as titanium, hafnium, zirconium, niobium, tantalum, chromium, and vanadium with these elements being preferably selected from titanium, niobium and tantalum, either alone or in combination with each other. These elements preferably may be added to the initial powder mixture as an element, alloy, carbide, nitride or carbonitride.

[0013] When these elements are present, it is preferable that the concentration of these elements (when present) is within the following ranges: the sum of the tantalum and niobium content is up to about 12 weight percent, and the titanium content is up to 6 weight percent. The more preferable concentration of these elements (when present) is that the sum of the tantalum content and the niobium content is between about 3 and about 7 weight percent and the titanium content is between about 0.5 and about 6 weight percent. The most preferable concentration of these elements (when present) is that the sum of the tantalum content and the niobium content is between about 4 and about 6.5 weight percent, and the titanium content is between about 1.5 and about 4.0 weight percent. For each one of the above-mentioned ranges for the sum of the tantalum and niobium contents, the maximum amount of the niobium content is preferably equal to about thirty percent of the sum of the tantalum and niobium contents.

[0014] In regard to the solid solution carbide forming elements in the bulk region of the substrate, it should be appreciated that these elements form, at least to some extent (and preferably for the most part), solid solution carbides and/or solid solution carbonitrides with the tungsten carbide in the substrate. However, these elements may be present as simple carbides, carbonitrides and nitrides and/or in combination with solid solution carbides.

[0015] Specific compositions of the bulk region for cemented carbide cutting inserts may include, but are not limited to, the compositions set forth below. These compositions produce a sintered substrate which has surface binder enrichment.

[0016] Composition No. 1 comprises about 5.8 weight percent cobalt, about 5.2 weight percent tantalum, no greater than about 0.4 weight percent niobium, about 2.0 weight percent titanium, and the balance tungsten

and carbon. For Composition No. 1, the average grain size of the tungsten carbide is between about 1 and about 8 micrometers ( $\mu\text{m}$ ), the specific gravity is between about 13.95 and about 14.25 grams per cubic centimeter ( $\text{g}/\text{cm}^3$ ), the Rockwell A hardness is between about 91.3 and about 91.9, the magnetic saturation is 100 percent, and the coercive force is between about 135 and about 185 oersteds. The description of the binder enrichment for Composition No. 1 is set forth in the above-mentioned Nemeth et al. article ("The Microstructure Features and Cutting Performance of the High Edge Strength Kennametal Grade KC850," by Nemeth et al. (Proc. Tenth Plansee Seminar, Metalwerke Plansee A.G., Reutte, Tyrol, Austria, (1981), pp. 613-627).

[0017] Composition No. 2 comprises about 6.0 weight percent cobalt, about 4.6 weight percent tantalum, about 1.0 weight percent niobium, about 3.5 weight percent titanium, and the balance tungsten and carbon. For Composition No. 2, the average grain size of the tungsten carbide is between about 1 and about 6  $\mu\text{m}$ , the specific gravity is between about 13.30 and about 13.60  $\text{g}/\text{cm}^3$ , the Rockwell A hardness is between about 91.8 and about 92.4, the magnetic saturation is between about 88 percent and about 100 percent, and the coercive force is between about 155 and about 205 oersteds.

[0018] Composition No. 3 comprises about 6.3 weight percent cobalt, about 3.5 weight percent tantalum, about 1.5 weight percent niobium, about 2.0 weight percent titanium, and the balance tungsten and carbon. For Composition No. 3, the average grain size of the tungsten carbide is between about 1 and about 7  $\mu\text{m}$ , the specific gravity is between about 13.80 and about 14.10  $\text{g}/\text{cm}^3$ , the Rockwell A hardness is between about 90.7 and about 91.3, the magnetic saturation is between about 88 and 100 percent, and the coercive force is between about 125 and about 155 oersteds.

[0019] The description of the binder enrichment for Compositions Nos. 2 and 3 is set forth in U. S. Reissue Patent No. 34,180 (U. S. Patent No. 4,610,931) to Nemeth et al.

[0020] The flank surface region 32 presents a microstructure which has a higher content of solid solution carbides than does the bulk region 30. For example, the bulk region may comprise tungsten carbide, cobalt, and a solid solution carbide of tungsten, titanium, niobium and tantalum while the flank surface region may comprise tungsten carbide and cobalt along with a higher concentration of a solid solution carbide or carbonitride of tungsten and titanium.

[0021] A preferable range of solid solution carbide enrichment for the flank surface region is between about 200 percent and about 400 percent of the solid solution carbide content of the bulk substrate. A more preferable range of solid solution carbide enrichment is between about 300 percent and about 400 percent of the bulk solid solution carbide content. The most preferable range of solid solution carbide enrichment is between about 350 percent and about 400 percent of the bulk

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solid solution carbide content.

[0022] A sintered substrate of Composition No. 3 had the following two coating schemes deposited as the layer 88 on the as-ground flank surface. Coating Scheme No. 1 comprised a 3 micrometer ( $\mu\text{m}$ ) thick PVD TiN/TiCN/TiN coating. Coating Scheme No. 2 comprised a CVD coating consisting of a 1  $\mu\text{m}$  thick inner layer of TiCN and a 7  $\mu\text{m}$  thick outer layer of TiN.

[0023] In the case of a cermet cutting insert, the substrate is a titanium carbonitride-based composition. The bulk composition of the cermet comprises between about 1 to about 14 weight percent cobalt, between about 3 to about 11 weight percent nickel, between about 5 to about 11 weight percent molybdenum, between about 13 to about 23 weight percent tungsten, up to about 10 weight percent tantalum, and the balance being titanium, carbon, and nitrogen. Specific compositions for the bulk region of the cermet substrate may include, but are not limited to, the following compositions:

Composition No. 4 comprises about 5.1 weight percent cobalt, about 4.2 weight percent nickel, about 10.2 weight percent molybdenum, about 21 weight percent tungsten, and the balance titanium, nitrogen, and carbon.

Composition No. 5 comprises about 1.8 weight percent cobalt, about 8.5 weight percent tantalum, about 9.8 weight percent nickel, about 10 weight percent molybdenum, about 15 weight percent tungsten, and the balance titanium, nitrogen, and carbon.

Composition No. 6 comprises about 12 weight percent cobalt, about 8 weight percent tantalum, about 6.5 weight percent molybdenum, about 4.3 weight percent nitrogen, about 17.5 weight percent tungsten, about 6 weight percent nickel, and the balance titanium and carbon.

[0024] The coating 26 may vary in thickness, but a preferable range is between 3 micrometers ( $\mu\text{m}$ ) and 12  $\mu\text{m}$ . The coating may be applied by any one of a variety of suitable techniques; however, the typical (and most preferable) techniques comprise chemical vapor deposition (CVD) and physical vapor deposition (PVD). The coating material may be any hard material such as, for example, cubic boron nitride (cBN), diamond, diamond like coating, titanium carbide, titanium nitride, titanium carbonitride, alumina, and titanium aluminum nitride.

[0025] Referring to FIG. 3, there is illustrated a cross-sectional view of a second specific embodiment of a cutting insert of the invention, generally designated as 50. Cutting insert 50 includes two rake face 52 and 53, and a flank face 54. The rake faces 52, 53 and the flank face 54 intersect to form a cutting edges 56, 57. The cutting edges may be in a sharp, honed (e.g., .0005 to .003 inch radius hone), chamfered, or chamfered and honed condition. The cutting insert 50 further includes a substrate 58 and a coating 60.

[0026] The substrate 58 presents two rake faces 62 and 64 and a flank face 66 which extends about the periphery of the substrate 58. The substrate 58 includes a bulk region 68 which presents a composition and microstructure that is of the basic bulk composition. These bulk compositions of cemented carbides and cermets are similar to those for the first specific embodiment of the cutting insert 10.

[0027] The substrate 58 further includes a first rake surface region 70 which begins at (or near) and extends inwardly from the rake face 62 of the substrate 58. The substrate 58 also includes a second rake surface region 72 which begins at (or near) and extends inwardly from the bottom rake face 64 of the substrate 58. The first rake surface region 70 and the second rake surface region 72 present a microstructure and composition that is enriched in the binder so that the binder content is higher in these regions (70, 72) than in the bulk region 68.

[0028] In regard to the extent of binder enrichment in the first and second rake surface regions, a preferable range of binder enrichment is between about 125 and about 300 percent of the bulk binder content. A more preferable range is between 150 and about 300 percent of the bulk binder content. The most preferable range is between about 150 and about 250 percent of the bulk binder content. FIG. 3 depicts the thicknesses of the first rake surface region 70 and the second rake surface region 72 in an exaggerated fashion for illustrative purposes. The typical thickness of these regions is described in the Nemeth et al. article and U. S. Reissue Patent No. 34,180 (U. S. Patent No. 4,610,931), to Nemeth et al.

[0029] The substrate 58 further has a flank surface region 76 which begins at (or near) and extends inwardly from the flank face 66 of the substrate 58. The microstructure (and composition) of the flank surface region 76 is different from that of the bulk region 68 in that the flank surface region 76 has a solid solution carbide content that is higher than the solid solution carbide content of the bulk region 68.

[0030] The preferable ranges for the extent of the solid solution carbide enrichment are the same as those set forth above on the description of the flank surface region 32 of cutting insert 10. These ranges will not be repeated herein, but are applicable to cutting insert 50. FIG. 3 depicts the thickness of the flank surface region 76 in an exaggerated fashion for illustrative purposes. The typical thickness of this region is between about 10  $\mu\text{m}$  and 20  $\mu\text{m}$ .

[0031] The cutting insert further includes a final coating 79 which is deposited on the surface of the substrate. The coating 79 is adjacent to the first surface rake region 70, the second surface rake region 72, and the flank surface region 76. The coating 79 may comprise one or more layers of various compounds. The coating 79 may also be deposited by chemical vapor deposition (CVD), physical vapor deposition (PVD) or both CVD and PVD.

[0032] The processes for producing the cutting inserts

(10, 50) are set forth below.

**[0033]** The first step in the basic process is to blend the powder components so as to provide a powder blend. It is typical that the blending will occur in a ball mill containing solvent, fugitive binder (or lubricant) and the powder charge ingredients. One example of the blending step is described in U. S. Patent No. 5,250,367, to Santhanam et al., for a Binder Enriched CVD and PVD Coated Cutting Insert, which is hereby incorporated by reference herein.

**[0034]** Once the powder components have been sufficiently blended and the charge dried, the powder blend will be pressed into the basic shape of the cutting insert so as to form a green compact. This green compact exhibits partial density, but not full density.

**[0035]** The next step is to sinter the green compact at a temperature above the liquidus of the metallic binder for a preselected time and at a preselected pressure. An exemplary temperature is 2650°F (1456°C), and an exemplary time is 45 minutes and an exemplary pressure is 5 torr argon. The green compact may be sintered to full density.

**[0036]** For certain compositions (e.g., Compositions Nos. 1, 2 and 3), the sintering step will result in the as-sintered substrate presenting a zone of binder enrichment beginning at or near the peripheral surface of the substrate and extending inwardly therefrom a certain distance, i.e., a binder enriched zone. The binder enriched zone exhibits a binder content which is greater than the binder content of the bulk substrate.

**[0037]** The next step is to grind the flank surface so as to remove the binder enriched zone which occurs during the sintering. It is optional to also grind the rake faces so as to remove the binder enriched zones. Thus, depending upon the specific application for the cutting insert, after the grinding step the cutting insert substrate may either present an as-ground flank surface and as-ground rake surfaces (which have the binder enriched zone ground off) or an as-ground flank surface (without binder enrichment) and as-sintered rake surfaces (which still present a binder enriched zone).

**[0038]** Then the next step is to take a plurality of the as-ground sintered substrates 80 and stack them on top of each other. FIG. 4 illustrates a plurality of the cutting insert substrates (where the flank surfaces as well as the rake surfaces have been ground) stacked on top of each other. These substrates 80 are stacked such that, except for the top substrate and the bottom substrate, the rake face 82 is contiguous to the rake surface 84 of the adjacent substrate 80. FIG. 4 makes it readily apparent that the top rake face 82 of the top substrate 80 and the bottom rake surface 84 of the bottom substrate are exposed. The flank face 86 of each substrate 80 is exposed.

**[0039]** The next step comprises depositing via CVD a layer 88 of a compound on the flank faces 86 of the sintered as-ground substrates 80. The compound for layer 88 is selected so as to form upon activation solid solu-

tions with the components of the substrate. When the substrate is a cemented carbide, the typical compounds for layer 88 include metal compounds (more preferably, carbides, nitrides, and carbonitrides) from the Group IVB, Group VB, and Group VIB transition metals such as, for example, titanium carbide, titanium nitride and titanium carbonitride.

**[0040]** The next step is to separate the sintered cutting insert substrates 80 and optionally remove material, i.e., grind and/or hone, from the surface regions of the substrates. Although it depends upon the particular application for the cutting insert, the substrate may be ground at the rake faces. It is typical to hone the cutting edges of the substrate. Grinding the rake faces of the sintered substrate removes any microstructure (e.g., a binder enriched zone, if present, at or near the surface of the rake faces) different from that of the bulk region.

**[0041]** The next step comprises the activation of the compound that comprises layer 88. The activation can occur through resintering the sintered substrate (with the layer 88 thereon) or through the localized application of heat or energy to the layer 88. The localized application of heat or energy can be applied through laser techniques or any other technique that focuses a high energy beam on (or applies high energy to) a localized area.

**[0042]** One result of the activation step is to cause one or more components of the substrate to diffuse toward the layer 88 so as to participate in the formation of a flank surface region. Another result of the activation step is to cause some or all of the compound which comprises layer 88 to diffuse toward the flank face of the substrate. This diffusion could be of one or more components, including one or more carbide-forming metals, of the compound toward the flank face of the substrate so as to also participate in the formation of a flank surface region. There is typically a two-way diffusion of components between the layer 88 and the substrate during the activation step wherein the majority of the diffusion, or the dominant diffusion mechanism, comprises the diffusion of the components of the substrate toward the layer 88. The preferred consequence of the activation step and the resultant diffusion mechanism is the disappearance of the distinct layer 88 and the formation of the flank surface region. The flank surface region, which presents a microstructure and composition that is different from that of the bulk substrate, begins at or near the peripheral surface of the flank face and extends a specific distance inwardly therefrom.

**[0043]** One typical case is where the bulk substrate is a cemented carbide-based composition that contains tungsten carbide and cobalt and the compound for layer 88 comprises titanium carbide, titanium nitride, or titanium carbonitride. During the activation step, the dominant diffusion mechanism is the diffusion of the tungsten carbide and cobalt toward the layer 88. In addition to the dominant diffusion mechanism, the titanium from the layer 88 diffuses toward the flank face. The diffusion in both directions, i.e., a two-way diffusion, forms the flank

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surface region (region 32 for insert 10 and region 76 for insert 50) in which there is a solid solution metal carbide of tungsten and titanium along with tungsten carbide and cobalt. The content of the (W, Ti)C in the flank surface region is higher than in the bulk region of the substrate. Upon completion of the activation step and the resultant diffusion, the distinct layer 88 of titanium nitride or titanium carbonitride ceases to exist.

[0044] In those cases in which the bulk region includes tungsten carbide, cobalt and other solid solution carbides and the compound for layer 88 comprises titanium carbide, titanium nitride, or titanium carbonitride, the components of the substrate (of which tungsten carbide is the dominant component) diffuses toward the layer 88. The titanium from layer 88 diffuses toward the substrate at the flank face whereby the two-way diffusion forms the flank surface region. The flank surface region has a higher overall content of the solid solution carbides, with (W, Ti)C being the dominant solid solution carbide, than the bulk region. The distinct layer 88 of titanium carbide, titanium nitride or titanium carbonitride ceases to exist as a result of the two-way diffusion mechanism.

[0045] After completion of the activation step the substrate may (or may not) be ground and the cutting edge honed to a preselected dimension. In a case where the objective is to produce a cutting insert substrate which has either one or both of the rake surfaces with a microstructure and composition different from that of the bulk region, one or both of these surfaces is not ground. For example, in regard to the cutting insert substrate of FIG. 3, there are two rake surface regions which exhibit a higher binder content than that of the bulk region. To maintain these regions of higher binder content, it is typical that the rake faces would not be subjected to grinding.

[0046] The next optional step comprises the application (or deposition) of the hard coating to selected areas of the cutting insert substrate so as to form the coated cutting insert. The cutting inserts illustrated in FIGS. 2 and 3 show that the coating (26, 60) covers the entire surface of the cutting insert substrate. However, it should be appreciated that, depending upon the specific application, only selected areas of the cutting insert substrate may have a coating therein. The coating may comprise one or more layers.

[0047] As mentioned above, the coating may be applied any one of a variety of coating techniques including CVD and PVD. Previously mentioned U. S. Patent No. 5,250,367, to Santhanam et al., discloses CVD and PVD methods to apply a hard coating to the cutting insert substrate.

[0048] In the case where the substrate is a cermet, the compound that constitutes the layer 88 would comprise compounds that form solid solution carbonitrides with the titanium in the titanium carbonitride. A suitable compound for layer 88 would comprise one hundred weight percent tungsten carbide.

## Claims

### 1. A cutting Insert comprising:

a flank face and a rake face, a cutting edge at a junction of the rake face and the flank face; the cutting insert having a substrate comprising a bulk region including a metallic binder, and one or more of a first metal carbide, a first metal carbonitride, a second metal carbide, and a second metal carbonitride either alone or in solid solution or in mixtures; the first metal being selected from the group consisting of the Group IVB, Group VB, and Group VIB transition metals, and the second metal being different from the first metal and being selected from the group consisting of the Group IVB, Group VB, and Group VIB transition metals; the substrate including a flank surface region near the flank face of the substrate, the substrate including a rake surface region near the rake face of the substrate; the flank surface region including a hard constituent comprising one or more of a solid solution of metal carbides and carbonitrides of the first metal and the second metal wherein at least a portion of the hard constituent in the flank surface region results from activation of a layer deposited on the flank surface wherein the layer is selected so as to form upon activation solid solutions with the components of the substrate, the content of the hard constituent in the flank surface region being greater than the content of the hard constituent in the bulk region; and the content of the hard constituent in the rake surface region being less than the content of the hard constituent in the flank surface region.

2. The cutting Insert of claim 1 wherein the composition of the rake surface region is substantially the same as the composition of the bulk region.

3. The cutting Insert of claim 1 wherein the metallic binder content of the rake surface region is between about 125 percent and about 300 percent greater than the metallic binder content of the bulk region.

4. The cutting Insert of claim 1 wherein the metallic binder content of the bulk region is higher than the metallic binder content of the flank surface region.

5. The cutting insert of claim 1 wherein the hard constituent content in the flank surface region is between about 200 percent and about 400 percent higher than the hard constituent content in the bulk region.

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6. The cutting insert of claim 1 wherein the first metal comprising tungsten; and the second metal comprising titanium, and the bulk region of the substrate comprising a major component of tungsten carbide and a minor component of solid solution carbides of tungsten and one or more of titanium, niobium, tantalum, hafnium, zirconium, and vanadium; and the metallic binder comprising cobalt. 5
7. The cutting insert of claim 6 wherein the bulk region of the substrate comprises the sum of tantalum and niobium being equal to up to about 12 weight percent, up to about 6 weight percent titanium, between about 3 and about 12 weight percent cobalt, and the balance being tungsten and carbon. 10 15
8. The cutting insert of claim 1 wherein the first metal comprising titanium and the second metal comprising tungsten, the bulk region of the substrate comprising tungsten carbide and the metallic binder comprising cobalt; and the flank surface region comprising cobalt and a solid solution carbide of tungsten and titanium. 20
9. The cutting insert of claim 1 wherein the first metal comprising titanium and the second metal comprising tungsten, the bulk region of the substrate comprising a major component of titanium carbonitride and a minor component of the solid solution carbides of titanium and one or more of tungsten, tantalum, and molybdenum, and the metallic binder comprising nickel and cobalt. 25 30
10. The cutting insert of claim 1 further including a coating bonded to the substrate, and the coating comprises one or more layers of one or more of the following components cubic boron nitride, diamond, diamond like coating, titanium carbide, titanium nitride, titanium carbonitride, alumina, and titanium aluminum nitride. 35 40
11. The cutting insert of claim 1 wherein the binder comprises one or more selected from the group consisting of cobalt, cobalt alloys, nickel, nickel alloys, iron, iron alloys, and combinations thereof. 45
12. A process for producing a cutting insert comprising the steps of:
  - sintering a powder mixture to form a sintered substrate with a rake face and a flank face, wherein the sintered substrate includes a metallic binder and a first metal carbide with the first metal selected from the group consisting of the Group IVB, Group VB, and Group VIB transition metals; 50
  - depositing a layer on the flank face wherein the layer contains one or more of a second metal carbide, a second metal carbonitride, and a second metal nitride, wherein the second metal is different from the first metal and is selected from the group consisting of the Group IVB, Group VB, and Group VIB transition metals; 55
  - activating the layer wherein at least one component of the substrate diffuses toward the layer and at least one component of the enrichment compound diffuses toward the substrate at the flank face so as to form a flank surface region near the flank face, the flank surface region having a solid solution metal carbide of the first metal and the second metal wherein the content of the solid solution metal carbide in the flank surface region is greater than the content of the solid solution metal carbide in the bulk region.
13. The method of claim 12 further including the step of coating the substrate with a coating.
14. The method of claim 13 further including, prior to the coating step, the step of forming a rake surface region in the sintered substrate near the rake face wherein the metallic binder content in the rake surface region is greater than the metallic binder content in the bulk region.
15. The method of claim 12 further including, after the sintering step, the step of removing material from selected areas of the flank face of the substrate.
16. The method of claim 12 wherein the activating step includes impinging a high energy beam on the flank face having the layer therein.
17. The method of claim 12 wherein the activating step includes sintering the substrate.
18. The method of claim 12 wherein after completion of the activation step the layer no longer exists as a discrete layer.
19. The method of claim 12 further including, after the sintering step and before the depositing step, the step of stacking a plurality of the as-sintered substrates on top of each other.
20. A coated cutting insert comprising:
  - a flank face and a rake face, a cutting edge at a junction of the rake face and the flank face; the cutting insert having a substrate comprising a bulk region including a metallic binder comprising one or more of cobalt and a cobalt alloy, and the substrate further comprising tungsten carbide, tantalum carbide, and titanium carbide either alone or in solid solution or in mixtures;



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the substrate including a flank surface region near the flank face of the substrate, the substrate including a rake surface region near the rake face of the substrate;  
 the flank surface region including a hard constituent comprising a solid solution carbide of two or more of tungsten, titanium and tantalum, the content of the hard constituent in the flank surface region being greater than the content of the hard constituent the bulk region;  
 the content of the hard constituent in the rake surface region being less than the content of the hard constituent in the flank surface region;  
 the content of the metallic binder in the rake surface region being greater than the content of the metallic binder in the bulk region and the flank surface region; and  
 a coating adhered to the surface of the substrate.

#### Patentansprüche

1. Schneideinsatz mit einer Freifläche und einer Spanfläche sowie einer Schneidkante am Zusammentreffen der Spanfläche und der Freifläche, bei dem

der Schneideinsatz ein Substrat aufweist, welches einen Kernbereich umfaßt, der ein Bindemetall sowie mindestens einen Vertreter aus der aus einem ersten Metallecarbide, einem ersten Metallecarbonitrid, einem zweiten Metallecarbide und einem zweiten Metallecarbonitrid bestehenden Gruppe enthält, und zwar jeweils allein oder in fester Lösung oder in Form von Gemischen;

das erste Metall ausgewählt ist aus der aus den Übergangsmetallen der Gruppen IVB, VB und VIB des Periodensystems bestehenden Gruppe und das zweite Metall, das vom ersten Metall verschieden ist, ausgewählt ist aus der aus den Übergangsmetallen der Gruppen IVB, VB und VIB des Periodensystems bestehenden Gruppe;

das Substrat einen Freiflächenbereich nahe seiner Freifläche sowie einen Spanflächenbereich nahe seiner Spanfläche aufweist;

der Freiflächenbereich einen Hartstoff enthält, der mindestens eine feste Lösung von Metallecarbiden und -carbonitriden des ersten und zweiten Metalls umfaßt, wobei mindestens ein Teil des Hartstoffs im Freiflächenbereich das Ergebnis der Aktivierung einer auf der Freifläche abgeschiedenen Schicht ist und die Schicht derart ausgewählt ist, daß sie nach Aktivierung feste Lösungen mit den Bestandteilen des Substrats bildet, wobei der Hartstoffgehalt im Freiflächenbereich größer ist als der Hartstoffgehalt im Kernbereich;

und wobei der Hartstoffgehalt im Spanflächenbereich kleiner ist als der Hartstoffgehalt im

Freiflächenbereich.

2. Schneideinsatz nach Anspruch 1, bei dem die Zusammensetzung des Spanflächenbereichs im wesentlichen gleich der Zusammensetzung des Kernbereichs ist.
3. Schneideinsatz nach Anspruch 1, bei dem der Bindemetallgehalt des Spanflächenbereichs etwa 125 % bis etwa 300 % größer ist als der Bindemetallgehalt des Kernbereichs.
4. Schneideinsatz nach Anspruch 1, bei dem der Bindemetallgehalt des Kernbereichs größer ist als der Bindemetallgehalt des Freiflächenbereichs.
5. Schneideinsatz nach Anspruch 1, bei dem der Hartstoffgehalt im Freiflächenbereich etwa 200 % bis etwa 400 % größer ist als der Hartstoffgehalt im Kernbereich.
6. Schneideinsatz nach Anspruch 1, bei dem das erste Metall Wolfram umfaßt und das zweite Metall Titan umfaßt und bei dem der Kernbereich des Substrats einen Hauptbestandteil aus Wolframcarbide und einen Nebenbestandteil aus in fester Lösung vorliegenden Carbiden aus Wolfram und mindestens einem der Metalle Titan, Niob, Tantal, Hafnium, Zirkonium und Vanadium umfaßt, und wobei das Bindemetall Kobalt umfaßt.
7. Schneideinsatz nach Anspruch 6, bei dem der Kernbereich des Substrats Tantal und Niob zusammen in einer Menge von bis zu etwa 12 Gew.-%, bis zu etwa 6 Gew.-% Titan, zwischen etwa 3 und etwa 12 Gew.-% Kobalt umfaßt, wobei der Rest Wolfram und Kohlenstoff ist.
8. Schneideinsatz nach Anspruch 1, bei dem das erste Metall Titan umfaßt und das zweite Metall Wolfram umfaßt, wobei der Kernbereich des Substrats Wolframcarbide umfaßt und das Bindemetall Kobalt umfaßt, und wobei der Freiflächenbereich Kobalt und ein in fester Lösung vorliegendes Carbide von Wolfram und Titan umfaßt.
9. Schneideinsatz nach Anspruch 1, bei dem das erste Metall Titan und das zweite Metall Wolfram umfaßt, der Kernbereich des Substrats einen Hauptbestandteil aus Titancarbonitrid und einen Nebenbestandteil aus in fester Lösung vorliegenden Carbiden von Titan und mindestens einem der Metalle Wolfram, Tantal und Molybdän umfaßt und das Bindemetall Nickel und Kobalt umfaßt.
10. Schneideinsatz nach Anspruch 1, der zusätzlich einen an das Substrat gebundenen Überzug aufweist, wobei der Überzug eine oder mehrere



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Schichten aus mindestens einer der folgenden Bestandteile umfaßt: kubisches Bornitrid, Diamant, eine diamantähnliche Beschichtung, Titancarbid, Tittannitrid, Titancarbonitrid, Aluminiumoxid und Titan-Aluminium-Nitrid.

11. Schneideinsatz nach Anspruch 1, bei dem der Binder mindestens ein Metall umfaßt, das aus der aus Kobalt, Kobaltlegierungen, Nickel, Nickellegierungen, Eisen, Eisenlegierungen und Kombinationen davon bestehenden Gruppe ausgewählt ist.

12. Verfahren zur Herstellung eines Schneideinsatzes, das folgende Schritte umfaßt:

Sintern eines Pulvergemischs unter Bildung eines gesinterten Substrats mit einer Spanfläche und einer Freifläche, wobei das gesinterte Substrat ein Bindemetall und ein erstes Metallcarbid aufweist, wobei das erste Metall aus der aus den Übergangsmetallen der Gruppen IVB, VB und VIB des Periodensystems bestehenden Gruppe ausgewählt wird;

Abscheiden einer Schicht auf der Freifläche, wobei die Schicht mindestens einen Vertreter aus der aus einem zweiten Metallcarbid, einem zweiten Metallcarbonitrid und einem zweiten Metallnitrid bestehenden Gruppe enthält, wobei das zweite Metall vom ersten Metall verschieden ist und ausgewählt wird aus der aus den Übergangsmetallen der Gruppen IVB, VB und VIB des Periodensystems bestehenden Gruppe;

Aktivieren der Schicht, wobei mindestens ein Bestandteil des Substrats zur Schicht hin diffundiert und mindestens ein Bestandteil der Anreicherungsverbindung an der Freifläche zum Substrat hin diffundiert, so daß ein Freiflächenbereich nahe der Freifläche gebildet wird, wobei der Freiflächenbereich ein in fester Lösung vorliegendes Metallcarbid des ersten und des zweiten Metalls aufweist und der Gehalt an in fester Lösung vorliegendem Metallcarbid in dem Freiflächenbereich größer ist als der Gehalt an in fester Lösung vorliegendem Metallcarbid in dem Kernbereich.

13. Verfahren nach Anspruch 12, das zusätzlich den Schritt der Beschichtung des Substrats mit einem Überzug umfaßt.

14. Verfahren nach Anspruch 13, das zusätzlich, vor dem Beschichtungsschritt, einen Schritt umfaßt, bei dem ein Spanflächenbereich im gesinterten Substrat nahe der Spanfläche gebildet wird, wobei der Bindemetallgehalt im Spanflächenbereich größer

ist als der Bindemetallgehalt im Kernbereich.

15. Verfahren nach Anspruch 12, das als zusätzlichen Schritt, nach dem Sintern, das Entfernen von Material von ausgewählten Bereichen der Freifläche des Substrats umfaßt.

16. Verfahren nach Anspruch 12, bei dem das Aktivieren das Auftreffen eines Strahls hoher Energie auf der die Schicht aufweisenden Freifläche einschließt.

17. Verfahren nach Anspruch 12, bei dem das Aktivieren das Sintern des Substrats einschließt.

18. Verfahren nach Anspruch 12, bei dem nach der Beendigung des Aktivierungsschrittes die Schicht nicht mehr als diskrete Schicht existiert.

19. Verfahren nach Anspruch 12, das als zusätzlichen Schritt, nach dem Sintern und vor der Abscheidung, das Übereinanderstapeln einer Mehrzahl von gesinterten Substraten umfaßt.

20. Beschichteter Schneideinsatz mit einer Freifläche und einer Spanfläche sowie einer Schneidkante am Zusammentreffen der Spanfläche und der Freifläche, bei dem

der Schneideinsatz ein Substrat mit einem Kernbereich aufweist, der ein Bindemetall aus Kobalt und/oder einer Kobaltlegierung enthält, wobei das Substrat ferner Wolframcarbid, Tantalcarbid und Titancarbid, jeweils entweder allein oder in fester Lösung oder in Form von Gemischen umfaßt; das Substrat einen Freiflächenbereich nahe seiner Freifläche und einen Spanflächenbereich nahe seiner Spanfläche aufweist;

der Freiflächenbereich einen Hartstoff enthält, der ein in fester Lösung vorliegendes Carbid von zweien oder mehreren der Metalle Wolfram, Titan und Tantal umfaßt, wobei der Hartstoffgehalt im Freiflächenbereich größer ist als der Hartstoffgehalt im Kernbereich;

der Hartstoffgehalt im Spanflächenbereich kleiner ist als der Hartstoffgehalt im Freiflächenbereich;

der Bindemetallgehalt im Spanflächenbereich größer ist als der Bindemetallgehalt im Kernbereich und im Freiflächenbereich;

und ein Überzug an der Substratoberfläche anhaftet.

## Revendications

1. Plaquette coupante comprenant :

une face de flanc, une face de coupe et une

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- arête coupante à la jonction de ces deux faces, la plaquette coupante ayant un substrat comprenant une région de coeur contenant un liant métallique et un ou plusieurs d'un carbure de premier métal, d'un carbonitride de premier métal, d'un carbure de deuxième métal et d'un carbonitride de deuxième métal soit seuls, soit en solution solide, soit en mélanges, le premier métal étant choisi dans le groupe constitué des métaux de transition du groupe IVB, du groupe VB et du groupe VIB, et le deuxième métal étant différent du premier et choisi dans le groupe constitué des métaux de transition du groupe IVB, du groupe VB et du groupe VIB, le substrat comportant une région de surface de flanc près de sa face de flanc et une région de surface de coupe près de sa face de coupe, la région de surface de flanc contenant un constituant dur comprenant un ou plusieurs d'une solution solide de carbures et carbonitrides du premier métal et du deuxième métal, au moins une partie du constituant dur de la région de surface de flanc résultant de l'activation d'une couche déposée sur la surface de flanc, cette couche étant choisie de façon à former lors de son activation des solutions solides avec les constituants du substrat, la teneur en constituant dur de la région de surface de flanc étant supérieure à la teneur en constituant dur de la région du coeur, et la teneur en constituant dur de la région de surface de coupe étant inférieure à la teneur en constituant dur de la région de surface de flanc.
2. Plaquette coupante selon la revendication 1, dans laquelle la composition de la région de surface de coupe est sensiblement la même que la composition de la région du coeur.
  3. Plaquette coupante selon la revendication 1, dans laquelle la teneur en liant métallique de la région de surface de coupe est supérieure d'environ 125 pour cent à environ 300 pour cent à la teneur en liant métallique de la région du coeur.
  4. Plaquette coupante selon la revendication 1, dans laquelle la teneur en liant métallique de la région du coeur est supérieure à la teneur en liant métallique de la région de surface de flanc.
  5. Plaquette coupante selon la revendication 1, dans laquelle la teneur en constituant dur de la région de surface de flanc est supérieure d'environ 200 pour cent à environ 400 pour cent à la teneur en constituant dur de la région du coeur.
  6. Plaquette coupante selon la revendication 1, dans laquelle le premier métal est du tungstène et le deuxième métal est du titane, et la région du coeur du substrat comprend un constituant majeur de carbure de tungstène et un constituant mineur de carbures en solution solide de tungstène et d'un ou de plusieurs du titane, du niobium, du tantale, du hafnium, du zirconium et du vanadium, et le liant métallique est du cobalt.
  7. Plaquette coupante selon la revendication 6, dans laquelle la région du coeur du substrat comprend une somme du tantale et du niobium s'élevant jusqu'à environ 12 pour cent en poids, jusqu'à environ 6 pour cent en poids de titane, entre environ 3 et environ 12 pour cent en poids de cobalt, le reste étant du tungstène et du carbone.
  8. Plaquette coupante selon la revendication 1, dans laquelle le premier métal est du titane et le deuxième métal est du tungstène, la région du coeur du substrat est en carbure de tungstène et le liant métallique est du cobalt, et la région de surface de flanc comprend du cobalt et un carbure en solution solide de tungstène et de titane.
  9. Plaquette coupante selon la revendication 1, dans laquelle le premier métal est du titane et le deuxième métal est du tungstène, la région du coeur du substrat comprend un constituant majeur de carbonitride de titane et un constituant mineur de carbures en solution solide de titane et d'un ou de plusieurs du tungstène, du tantale et du molybdène, et le liant métallique comprend du nickel et du cobalt.
  10. Plaquette coupante selon la revendication 1, comportant en outre un revêtement uni au substrat, ce revêtement comprenant une ou plusieurs couches d'un ou de plusieurs des constituants suivants : nitrure de bore cubique, diamant, revêtement du genre diamant, carbure de titane, nitrure de titane, carbonitride de titane, alumine et nitrure de titane-aluminium.
  11. Plaquette coupante selon la revendication 1, dans laquelle le liant comprend un ou plusieurs constituants choisis dans le groupe constitué du cobalt, des alliages de cobalt, du nickel, des alliages de nickel, du fer, des alliages de fer et des combinaisons de ceux-ci.
  12. Procédé de production d'une plaquette coupante, comprenant les étapes de :
    - frittage d'un mélange de poudres pour former un substrat fritté ayant une face de coupe et une face de flanc, le substrat fritté contenant un liant métallique et un carbure de premier métal, le premier métal étant choisi dans le groupe

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constitué des métaux de transition du groupe IVB, du groupe VB et du groupe VIB.

dépôt d'une couche sur la face de flanc, cette couche contenant un ou plusieurs d'un carbure de deuxième métal, d'un carbonitride de deuxième métal et d'un nitrure de deuxième métal, le deuxième métal étant différent du premier et choisi dans le groupe constitué des métaux de transition du groupe IVB, du groupe VB et du groupe VIB,

activation de la couche, au moins un constituant du substrat diffusant vers la couche et au moins un constituant du composé d'enrichissement diffusant vers le substrat à la surface de flanc afin de former une région de surface de flanc près de la face de flanc, la région de surface de flanc ayant un carbure en solution solide du premier métal et du deuxième métal, la teneur en carbure métallique en solution solide de la région de surface de flanc étant supérieure à la teneur en carbure métallique en solution solide de la région du coeur.

13. Procédé selon la revendication 12, comprenant en outre l'étape de revêtement du substrat d'un revêtement. 25
14. Procédé selon la revendication 13, comprenant en outre, avant l'étape de revêtement, l'étape de formation d'une région de surface de coupe dans le substrat fritté près de la face de coupe, la teneur en liant métallique de la région de surface de coupe étant supérieure à la teneur en liant métallique de la région du coeur. 30
15. Procédé selon la revendication 12, comprenant en outre, après l'étape de frittage, l'étape d'enlèvement de matière de zones choisies de la face de flanc du substrat. 35
16. Procédé selon la revendication 12, dans lequel l'étape d'activation comprend la frappe d'un faisceau à haute énergie sur la face de flanc contenant la couche. 40
17. Procédé selon la revendication 12, dans lequel l'étape d'activation comprend le frittage du substrat. 45
18. Procédé selon la revendication 12, dans lequel, à l'issue de l'étape d'activation, la couche n'existe plus en tant que couche discrète. 50
19. Procédé selon la revendication 12, comprenant en outre, après l'étape de frittage et avant l'étape de dépôt, l'étape d'empilage les uns sur les autres de plusieurs substrats à l'état fritté. 55
20. Plaquette coupante revêtue comprenant :

une face de flanc, une face de coupe et une arête coupante à la jonction de ces deux faces. la plaquette coupante ayant un substrat comprenant une région de coeur contenant un liant métallique comprenant un ou plusieurs du cobalt et d'un alliage de cobalt, et le substrat comprenant en outre du carbure de tungstène, du carbure de tantale et du carbure de titane soit seuls, soit en solution solide, soit en mélanges, le substrat comportant une région de surface de flanc près de sa face de flanc et une région de surface de coupe près de sa face de coupe, la région de surface de flanc contenant un constituant dur comprenant un carbure en solution solide de deux ou plus du tungstène, du titane et du tantale, la teneur en constituant dur de la région de surface de flanc étant supérieure à la teneur en constituant dur de la région du coeur,

la teneur en constituant dur de la région de surface de coupe étant inférieure à la teneur en constituant dur de la région de surface de flanc, la teneur en liant métallique de la région de surface de coupe étant supérieure à la teneur en liant métallique de la région du coeur et la région de surface de flanc, et un revêtement étant uni à la surface du substrat.

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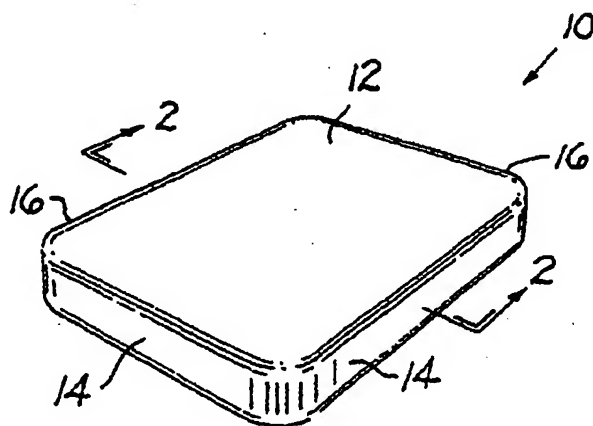


FIG. 1

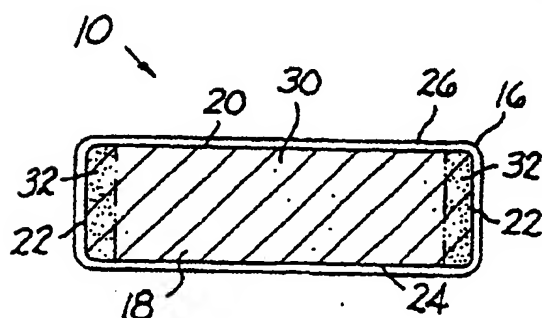


FIG. 2

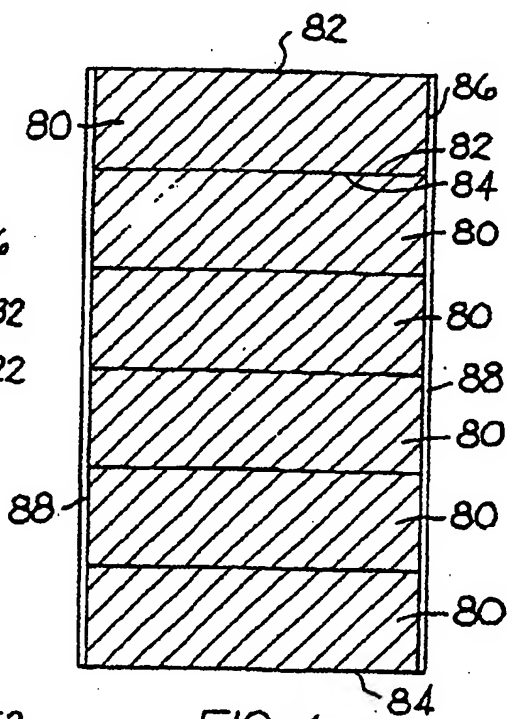


FIG. 4

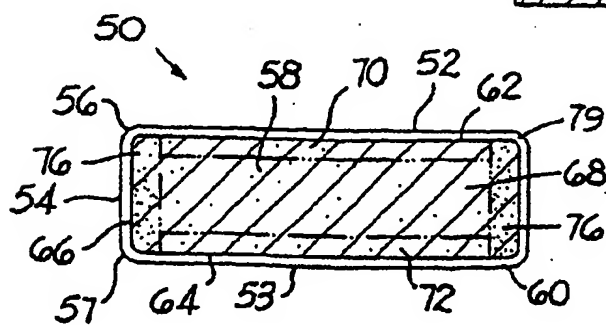


FIG. 3